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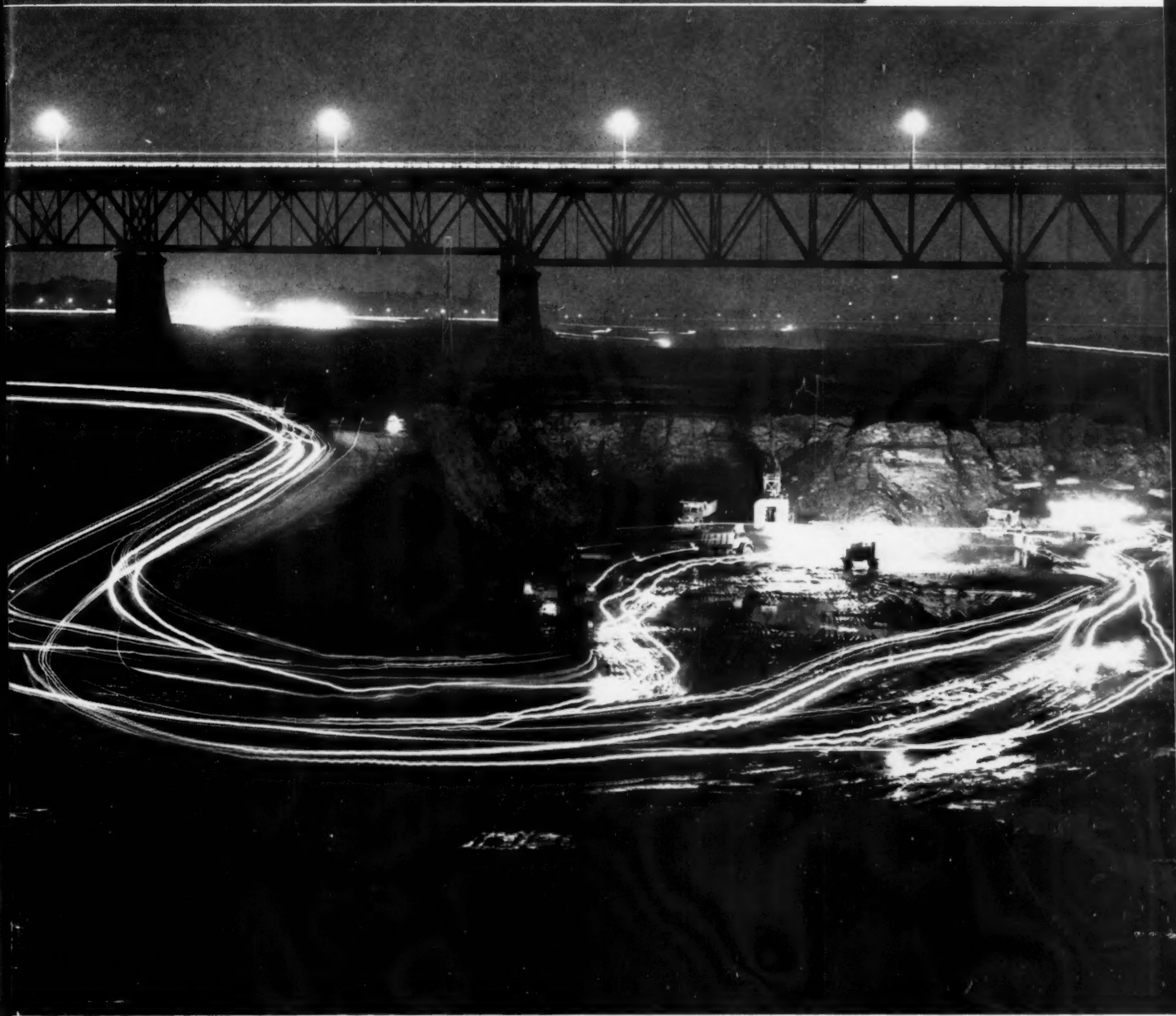

Occupational Health Division

DEPARTMENT OF NATIONAL HEALTH AND WELFARE, OTTAWA

Occupational Health Review

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COVER PHOTO BY MALAK

GARAGE HEALTH HAZARDS AND VENTILATION

By C. R. Ross, M.S., P. Eng., and L. Rispler, B.Sc., P. Eng.
Occupational Health Division,
Department of National Health and Welfare.

SOURCES OF AIR CONTAMINANTS

Engine Exhaust Cases

Carbon monoxide exists in gasoline engine exhaust gases in concentrations ranging from over 10 per cent at idle speed to about three per cent at full speed. Since engines normally discharge about one cubic foot of exhaust gases per minute per operating horsepower, a substantial quantity of carbon monoxide can be produced to quickly form harmful concentrations in a garage. While most people are aware that high concentrations of carbon monoxide can be fatal, the effects of exposure to lower concentrations are not so widely known. Continuous exposure to low concentrations in the order of 0.01% carbon monoxide in the air may produce unnoticed reductions of efficiency and working capacity, and mild headaches. Higher concentrations cause more pronounced symptoms such as dizziness, dimness of vision, nausea and finally, collapse. As the concentration is increased these symptoms are observed in shorter times. For example, concentrations of about 0.1% can result in dizziness within an hour, while breathing concentrations of 0.4% can be fatal within an hour. A particularly dangerous feature of high concentrations of carbon monoxide is the fact that the gas itself is quite odorless and therefore can strike suddenly without warning, or with only a brief feeling of dizziness, by which time the victim may be unable to make his way to fresh air before collapsing.

The amount of carbon monoxide in the exhaust of diesel engines is considerably less than in gasoline engines. However, diesel engine exhaust fumes also contain small amounts of aldehydes which are objectionable because of their odor and irritant properties, and nitrogen dioxide which is quite harmful to health in low concentrations.

Figure 1 is a record of carbon monoxide concentrations in a garage. Recurring cycles of sharply increased concentrations with vehicle operation were followed by more gradual dissipation of the concentrations. The difficulty of interpreting results of spot-sampling for carbon monoxide in garages can be appreciated.

The infra-red analyzer illustrated in Figure 2 indicates the amount of carbon monoxide present by measuring the absorption of its characteristic wave length. In another type of continuous indicator the air sampled is passed through a catalyst which oxidizes carbon monoxide to carbon dioxide. Measurement of the heat of reaction is proportional to the amount of carbon monoxide present in the air.

Small glass detector tubes containing chemically impregnated silica gel are available for individual spot samples. Carbon monoxide in the air sample drawn through the tube reacts with the chemicals to produce a color change. The amount of carbon monoxide present is determined either by measuring the length of coloration produced, or by comparing the intensity of the color with a standard color chart.

Solvent Vapours

Organic solvents all have harmful effects on health, although some are much more harmful than others. Benzol and carbon tetrachloride are examples of dangerous solvents which may damage internal organs if inhaled, swallowed or absorbed through the skin in small quantities. Naphtha cleaning solvent and methyl chloroform are examples of solvents which have little effect on health in moderate concentrations. Breathing excessive amounts of any solvent may result in loss of co-ordination, drowsiness and similar symptoms leading to decreased efficiency and increased risk of accident. In addition to inhalation effects, all solvents have a defatting action on the skin, which may cause dermatitis.

The solvents used in automobile spray paints, undercoating compounds and thinners are of moderate to low toxicity. Because they evaporate readily during the spraying process, however, concentrations harmful to health may readily develop under conditions of poor ventilation. The flammability and explosibility of paint solvents are well known in repair garages. It is perhaps not so well known that health safety limits of paint solvents are only one to two per cent of lower explosive limits. For example, the volume of air required to dilute one quart of toluene to the lower

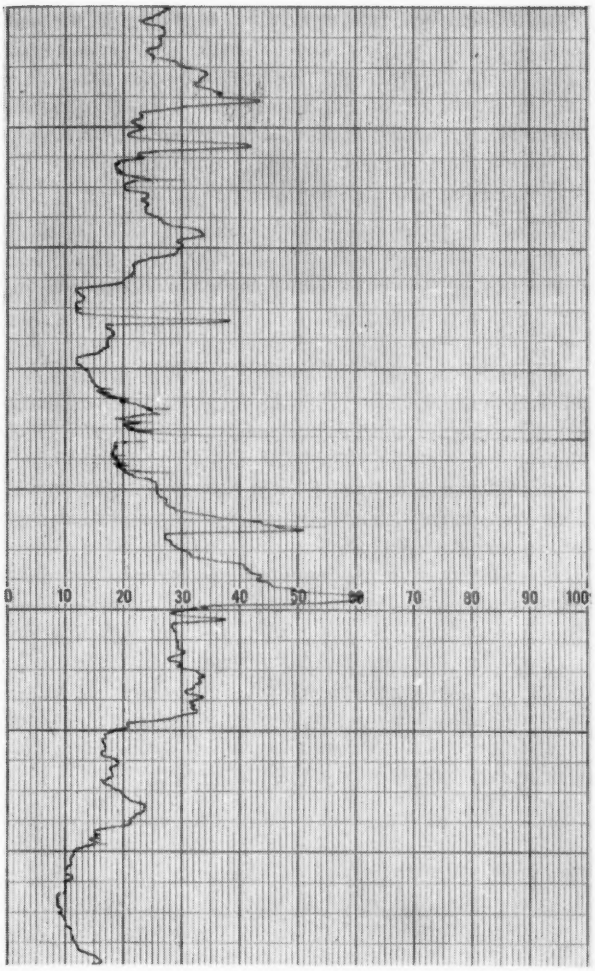


Fig. 1. — Strip-chart recording of carbon monoxide concentration in a garage, as measured by an infra-red analyzer. 100 on chart is 0.03% carbon monoxide.

explosive limit of 1.4% would be about 660 cubic feet while 46,000 cubic feet of air would be required to dilute the same amount of vapour to the health safety limit of .02%.

Naphtha cleaning solvent is the most commonly employed cleaning solvent in garages and is relatively safe. The safety of other solvents which may be required for cleaning or degreasing should be investigated before they are used. It is often possible to substitute a less harmful solvent for one that is more harmful and do just as good a job of cleaning.

Dust and Fumes

Fumes produced during welding or brazing operations originate from the materials welded, from the coatings on the surface being welded or cut, from the welding electrodes, from the coatings of electrodes or from fluxes. These fumes may contain lead, fluorides or other substances which are poisonous if inhaled in sufficient quantities.

Injurious gases are also produced by the welding arc or flame and include nitrogen dioxide, ozone and carbon monoxide. When welding is carried on in enclosed, unventilated areas, dangerous amounts of these gases may be produced in a very short time.

The dusts generated during grinding and buffing body surfaces may contain lead, chromates or other toxic substances derived from paint finishes and body fillers.

Similar dusts are produced during spray painting.

VENTILATION

Local Exhaust Ventilation and General Ventilation

Local exhaust systems remove air contaminants at their points of origin before they can escape into the general atmosphere. General ventilation refers to the commonly understood ventilation process in which the general space is constantly flushed with fresh, outdoor air. Local exhaust systems should be considered whenever possible because they obtain positive control of contaminants with a minimum amount of air. General ventilation systems are required for contamination that originates at scattered points dispersed generally throughout the area. A combination of local exhaust and general ventilation is often required.

Quantities of tempered make-up air should be provided to balance the total air exhausted in order to

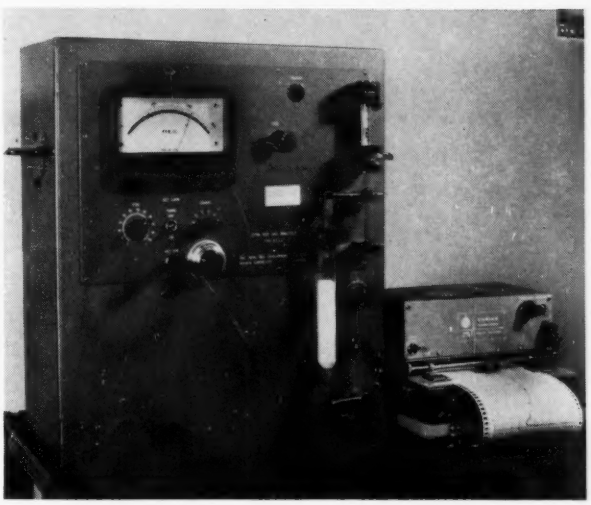


Fig. 2. — Infra-red analyzer for carbon monoxide. Measurements are continuously recorded on the portable strip-chart recorder.

ensure that exhaust hoods operate properly. A positive heated air supply does not increase heating costs and provides greater comfort by eliminating drafts through doors, windows and cracks. When a combination of local exhaust and general ventilation is used, the outdoor air supply unit of the general ventilation system can also fulfil make-up air requirements. The air supply is located to obtain cross-ventilation of the area, and in this way the volume of air handled may serve two functions at the same time; first, to provide general ventilation and, second, to supply make-up air for the exhaust systems.

Location of exhaust hoods and other air outlets or inlets must not be based on the fact that the contaminant is "heavier" or "lighter" than air. Dust particles in the harmful size range, fumes, vapors and gases readily mix by diffusion with air and the mixture very quickly attains a density essentially the same as air regardless of their own density. They follow air currents and are not subject to appreciable upward or downward motion.

Fig. 3. — Dual exhaust connection to floor inlet of ventilation system.

LOCAL EXHAUST SYSTEMS

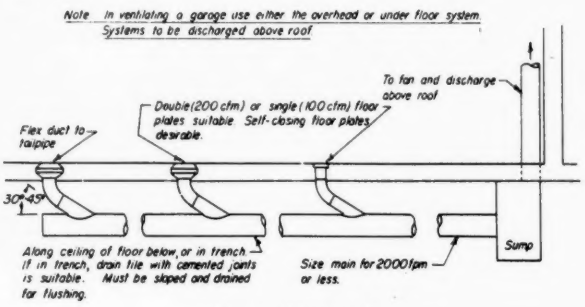
An exhaust system consists of hoods or enclosures at the sources of air contamination, branch and main ducts through which an air stream transports the contaminant outdoors, a fan to produce the required air flow, and in some cases an air cleaner.

Tailpipe Exhaust Systems

Motor vehicle servicing areas may be provided with an exhaust system to remove exhaust fumes from the tailpipes, as shown in Figure 3. Each service location is provided with a flexible branch duct which can be slipped over the tailpipe, with special adapters for dual exhaust and exhaust deflectors. These flexible branch ducts are connected to main exhaust ducts which can run overhead or under the floor (one main exhaust duct could serve two floor levels). The exhaust gases are finally discharged above the roof at a point where fumes cannot re-enter the building.

The minimum size and ventilation rate for each flexible duct should be adequate for the largest class of vehicle regularly serviced at that location. For example, a ventilation rate of 100 cubic feet per minute with a 3-inch diameter flexible duct may be suitable for gasoline engines up to 200 horsepower, but a rate of 400 cubic feet per minute and 4½-inch diameter duct would be required for a diesel engine. Special care should be taken to select the proper sizes of flexible duct and to use as short a length as possible because of its resistance to air flow. Otherwise the total resistance of the exhaust system may require a relatively larger fan and motor horsepower to ensure the required amount of air will be drawn through the ducts. Flexible hose which can be driven over by cars without damage to the hose is also desirable. Automatic devices to close branch inlets when they are not in use may also reduce fan capacity requirements, as selection of the fan could be based on the maximum possible number of branches in simultaneous use.

Fig. 4 — Garage Ventilation.


Note In ventilating a garage use either the overhead or under floor system. Systems to be discharged above roof
To fan and discharge above roof
Double(200 cfm) or single(100 cfm) floor plates suitable. Self-closing floor plates desirable.
Flex duct to tailpipe
30°-45°
Along ceiling of floor below, or in trench if in trench, drain tile with cemented joints is suitable. Must be sloped and drained for flushing.
Size main for 2000 fpm or less.
Sump

UNDER FLOOR SYSTEM

EXHAUST REQUIREMENTS *

Type	CFM per vehicle	Dia. flex duct (min)
Automobiles and trucks up to 200 hp	100	3"
Automobiles and trucks over 200 hp	200	4" * *
Diesel	400	4 1/2"

Friction loss for flexible duct; (1.5-2.0) × standard duct. Consult manufacturers' data.

Use adapters on dual exhausts and special tailpipes.

PARKING AND STORAGE:

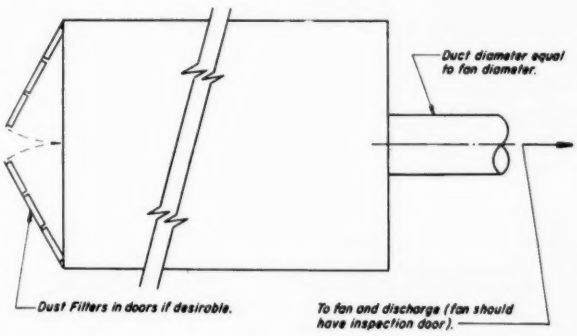
Also provide dilution ventilation for cars in motion or idling outside of stalls.

DILUTION RATES:

5000 cfm/running automobile.
10,000 cfm (or more)/truck.
100 cfm/horse power for diesel.

* * 3" dia. permissible for short runs with proper fan.
* On dynamometer test rolls double cfm requirements.

Essentials of good tailpipe ventilation systems are shown in Figure 4. Systems of this type are available in kit form from a number of commercial suppliers. The large general ventilation volumes needed to dilute engine exhaust gases are also shown in Figure 4.


Duct diameter equal to fan diameter.
Dust Filters in doors if desirable.
To fan and discharge (fan should have inspection door).

Q = 100 cfm / sq. ft. of cross-section area.
Entry loss = 0.50 VP plus resistance of each filter bank when dirty.
Duct velocity = 2000 fpm.
All filters to be sized for 275 cfm / sq. ft. of filter.
See Fig. 4-9 for information on methods of distribution.

Fig. 5 — Auto Spray Paint Booth

Spray Painting Exhaust Systems

Automobiles may be safely repainted only in spray paint booths or rooms especially designed for this purpose. Air should be drawn through the booth from one end to the other in order to avoid areas of high spray concentration. Baffles ahead of the fan intake help to maintain an even air distribution. Where discharge of contaminated air from paint rooms may contaminate a neighbouring area, the baffles can be replaced by wet or dry filters. Filters also prevent accumulation of over-spray on fan and ductwork which may be a fire hazard.

Filters are commonly installed in the entry doors to protect quality of work, and these should be sized in accordance with the air volume exhausted. In order to maintain the recommended air velocity of 100 linear feet per minute through the paint room it is important that used filters are promptly replaced, because the capacity of fans usually installed in paint rooms drops

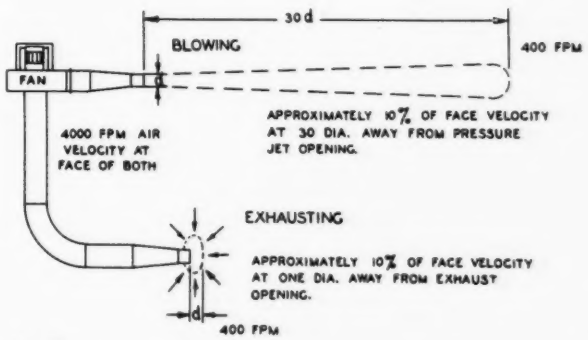
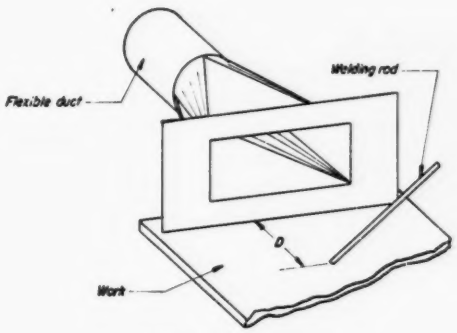

30 d
BLOWING
400 FPM
FAN
APPROXIMATELY 10% OF FACE VELOCITY AT 30 DIA. AWAY FROM PRESSURE JET OPENING.
4000 FPM AIR VELOCITY AT FACE OF BOTH
EXHAUSTING
APPROXIMATELY 10% OF FACE VELOCITY AT ONE DIA. AWAY FROM EXHAUST OPENING.
400 FPM

Fig. 7 —



PORTABLE EXHAUST

D, inches	*CFM*
6	*250*
9	*400*
12	*1000*

Duct velocity = 3000 fpm minimum
Entry loss = 0.5 VP
Also see "Granite Cutting" VS-10

OTHER TYPES OF HOODS

Sidedraft:
See "Soldering" VS-30

Booth:
Q = 100 cfm/sq. ft. of face
See "Spray Painting" VS-61, 62
"Metal Spraying" VS-23

GENERAL VENTILATION, where local exhaust cannot be used:

**Note: For toxic materials higher airflows are necessary.*

Rod, dia.	*CFM/welder**
5/32	*1000*
3/16	*1500*
1/4	*3500*
3/8	*4500*

Fig. 8 — Welding (Arc)

Fig. 6. — Auto spray paint booth in operation.

substantially with slight increases in system resistance. Replacement can best be timed by installation of a filter pressure gauge to indicate the extent of filter loading.

The protection afforded by exhaust ventilation of spray paint rooms should be supplemented, while painting, by respirators approved for protection against toxic dusts and organic vapours. Individual respirators should be issued and fitted to each operator. Replacement of filter pads and chemical cartridges should be made according to a regular schedule.

Welding Exhaust Systems

Portable exhaust hoods, connected with flexible duct, can be used effectively in garages to remove welding fumes. The amount of exhaust air required to control the fumes can be minimized with a properly designed flanged hood placed close to the weld line. It is not generally understood that the effective range of exhaust systems is inherently small. This difference between blowing and exhaust systems is illustrated in Figure 7. Exhaust systems for welding are very similar to tailpipe exhaust systems. A suitable hood is illustrated in Figure 8.

General Ventilation Systems

General ventilation should be provided to take care of vehicles in motion or idling outside of servicing areas and leaking exhaust systems of vehicles in the servicing areas. Also, other operations such as body repair, use of solvents and welding which may not be extensive enough to require local exhaust systems must therefore be taken into consideration in the design of the general ventilating system. Some provisions should be made for solvent storage areas.

In designing general ventilation systems for other than very small garages it is not sufficient just to install exhaust fans of capacity sufficient to dilute contaminants to safe concentrations. Tempered air must be supplied in an amount equal to that being exhausted if good air conditions are to be attained. The location of air inlets and outlets should be carefully chosen for proper air distribution, and equipment for tempering the air in cold weather should be selected so that proper temperature control can be obtained throughout the area.

An air supply system does not add to the heating costs and eliminates cold drafts and problems of air starvation of exhaust systems when buildings are tightly closed during cold weather.

Operation of Ventilation Equipment

After ventilation systems are installed they should receive proper maintenance because hazards will remain controlled only as long as the systems function properly. In many cases little attention is given to such installations, yet they require the same care that tools and other garage equipment usually receive. The maintenance schedule should include periodic measurements of air quantities to determine if further maintenance or repairs of a system are necessary to assure efficient operation.

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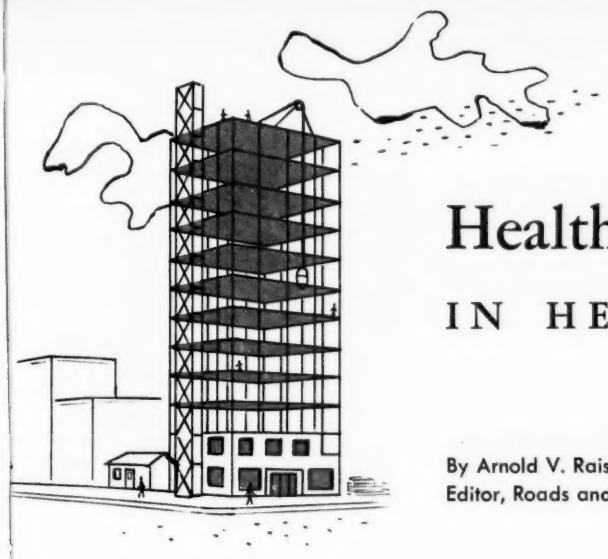


Health Hazards

IN HEAVY CONSTRUCTION

By Arnold V. Raison, B.A.,
Editor, Roads and Engineering Construction

Medical and Engineering Control of Health Hazards, Combined With a Sound Employee Health Education Program Will Not Only Reduce Occupational Illness, But will Save Time and Money for the Contractor.

Over the past three or four decades, the heavy construction industry has become increasingly concerned with accident-prevention and other aspects of safety — a commendable development. But little has been done to control the health hazards which may exist in the working environment.

Some people have adopted the attitude that, since this is predominantly an outdoor industry, there are no health hazards. This is a gross misconception, to say the least, one which is, no doubt, based on the belief that the great outdoors is the panacea for all ills. No industry today is completely free from health hazards.

The impact of occupational illness on the heavy construction industry is difficult to assess because of incomplete reporting of cases by both management and affected workers, failure of some physicians to recognize diseases of occupational origin, and the transient nature of the industry, which can complicate matters, particularly with health hazards which do not produce immediate effects.

A sound health program for heavy construction workers, apart from personal concern, is good business. Healthy workers are more productive and efficient and less prone to accidents. However, before an effective program can be established, it is first of all necessary to determine what hazards exist in the environment, the best way to avoid exposure, and the routine to be followed in arranging for treatment.

Health Hazards

In any outdoor occupation, climate and weather conditions can, in themselves, introduce health hazards. In cold weather regions there are the possibilities of frost-bite, respiratory affections, and the difficulty of providing adequate sanitation facilities; excessive exposure to direct sunlight can result in sunburn, heat cramps, heat stroke or heat exhaustion; and in certain areas, particularly tropical, insect-transmitted diseases, such as malaria, are always a threat to the health of workers.

Construction workers are frequently exposed to poisonous or non-poisonous dusts, fumes, gases, mists, vapours, or a combination of these. Even the non-toxic substances may ultimately be harmful, depending on the density and frequency of exposure. Some of these may exert harmful effects on the skin; some may gain entrance to the body by inhalation or ingestion, and create local irritation of the tissues in the respiratory and digestive tracts; some may be absorbed into the body and cause systemic poisoning; and some may be capable of producing a combination of these effects.

Other problems include eye injuries from foreign bodies entering the eye, flash injury (arc-eye), eye burns from electric welding, loss of hearing from excessive noise, injury to the nervous system from vibrating tools, caisson disease, or "bends" from abnormal air pressure, skin rashes from contact with poisonous plants, allergic reactions to certain substances in the environment, and suffocation from oxygen-deficient atmospheres.

Dermatitis

Any disease or inflammation of the skin is commonly referred to as dermatitis. Dermatitis, particularly of the hands, face and other exposed areas of the skin, constitutes a large proportion of the occupational diseases encountered in heavy construction.

Reprinted from Roads and Engineering Construction, January, 1960.

The outer layer of the skin normally affords protection for the underlying tissues against most dusts and bacteria, but certain agents can overcome this barrier and cause painful irritation or infection.

Some solvents, such as gasoline, carbon tetrachloride and other cleaning and degreasing liquids will dissolve the protective oils in the skin, leaving it dry and cracking, and vulnerable to bacterial infection. If it is impossible to avoid skin contact, defatting of the skin can be prevented by applying a hand lotion containing a skin softener such as lanolin. Workers should be discouraged from using strong solvents for cleaning grease or other dirt from the hands. There are plenty of "safe" hand cleaners on the market today which do a thorough cleaning job without harming the skin.

Skin contact with asphalt and bitumen sometimes causes skin eruptions resembling acne; and oil dermatitis is not uncommon among asphalt workers. Prolonged or frequent intermittent exposure of the skin to tar and direct sunlight has been known to produce skin cancer. Immediate removal of the offending substances, supplemented by personal cleanliness and avoidance of exposure will go far in preventing these affections.

Corrosive dusts, such as cement, lime and harsh powdered cleaning agents will dissolve in perspiration and form strong alkaline solutions which can produce skin lesions and other painful sequelæ. Prolonged contact with wet concrete will produce similar effects. Continued contact may result in sensitization of the skin, which may require long-term treatment to cure. To guard against this situation, keep these substances off the skin. Clothes should be kept dry, hands protected by gloves or a recommended protective cream, and all contaminated areas washed off immediately.

Some workmen are allergic to, or become sensitized to certain materials in the environment, and will develop moderate to severe local and, sometimes, general skin reactions, accompanied by annoying itching and discomfort following contact. The principal agents in this class are poison ivy, poison oak, poison sumac and some tropical woods. If not treated immediately, the involved areas may become secondarily infected, with painful consequences. These agents may be encountered on almost any construction job, especially highway construction, surveying and pole line work. A fact which is frequently overlooked with these plants is that contact with the roots can produce dermatitis, even when the ground is frozen in winter. Avoidance is the only sure prevention but since this is frequently impossible, precautions should be taken to minimize the danger of skin contact. Keep hands and ankles covered while working in the area, and if contamination of the skin is suspected, wash the area thoroughly with soap and water as soon as possible. Contaminated clothing should be disinfected to prevent further exposure.

Early treatment of skin affections is important to prevent the condition becoming chronic.

Ingested Materials

Poisonous or non-poisonous dusts or liquids can get into the stomach in various ways — by breathing in dusts through the mouth and swallowing the contaminated saliva, drinking contaminated drinks, smoking, chewing gum, eating candy or food without first washing the hands.

Effects of swallowing poisonous substances may vary from a mild nausea or dyspepsia to violent nausea, vomiting, and even convulsions, if sufficient quantities of a highly toxic material is absorbed through the wall of the stomach.

Inhalation Hazards

Certain fumes, vapours and gases, if inhaled in sufficient concentration, can irritate the lungs and breathing passages, and some may cause systemic poisoning if absorbed into the blood stream. Carbon monoxide from incomplete combustion of commonly used fuels is particularly dangerous because the gas is odourless and colourless, and lethal quantities may be inhaled unknowingly. Although most people know about the dangers of carbon monoxide, cases of illness and death from this gas are still too prevalent. The Michigan Department of Health estimates that it causes 46 per cent of the deaths from accidental poisoning in that state. Much of the danger of exposure can be eliminated by proper ventilation in garages and other areas where stoves or engines are commonly used, and keeping burners or other combustion equipment clean and in good working order.

Inhalation of the fumes or vapours produced by heating tar or pitch has been known to cause headache, dizziness, nausea, loss of appetite, respiratory irritations and other maleffects.

In high-temperature welding, with oxyacetylene or electric torch, certain toxic oxides of nitrogen are formed which, if inhaled in sufficient quantity, will cause headache and dizziness, tightness and burning in the chest, shortness of breath, sleeplessness and restlessness. In a severe case of exposure, breathing may become increasingly difficult and painful, with cyanosis developing, followed by loss of consciousness and death.

Since the irritant qualities of nitrous fumes are relatively low, dangerous quantities may be inhaled before any real discomfort occurs. Higher concentrations cause immediate nose and throat irritation ac-

companied by coughing. These symptoms often disappear when fresh air is breathed, and the victim may feel well for several hours. However, symptoms of poisoning may develop within 6 to 24 hours.

Proper ventilation will prevent over-exposure, and where this is impossible, approved respiratory protection should be provided and worn.

Lead and zinc fumes from welding of substances containing these elements can also be dangerous to health of workers if inhaled in sufficient concentrations. Where such exposure is known or suspected, approved respirators should be provided and adequate ventilation insured.

Lead workers should have routine blood tests (every 3 months) as a control measure.

All cleaning and degreasing solvents require caution in their use. One of these which has been very popular in this regard is carbon tetrachloride, because of the distorted sense of security engendered by the fact that it is non-flammable. Vapours from "carbon tet" are extremely poisonous, and a number of deaths from acute exposure to even small concentrations have been reported. Also, in the presence of sufficient heat, carbon tet breaks down to form even more dangerous compounds which increase the hazards of its use in fire extinguishers.

Certain poisonous gases are sometimes encountered in underground operations such as tunneling, shaft driving, raise driving and mining. Among these are methane (Marsh gas), hydrogen sulphide, and carbon monoxide. Hydrogen sulphide is even more dangerous than carbon monoxide, because even 2 or 3 breaths of the gas in high concentration may be fatal. If these gases are suspected, properly fitted and approved respiratory equipment should be worn. Here again, adequate ventilation is important to prevent heavy concentrations of the gases from accumulating in the work area. Any shortness of breath, rapid breathing, dizziness or other untoward symptoms should be a signal for unprotected workers to leave the area immediately until tests have been run for gases.

Oxygen deficient atmospheres are often blamed for suffocation mishaps when actually the cause is most commonly carbon dioxide. Although not classed as a poison, excess carbon dioxide in an atmosphere may serve to lower the percentage of oxygen in the inspired air, and the result is asphyxia if exposure is prolonged. Of course, in certain underground operations, oxygen deficiencies may result from the oxygen being used up in chemical reaction with metals.

Eye Injuries and Affections

Conjunctivitis is caused by foreign particles entering the eye. Injuries may result from flying particles off grinders; lime, cement, acids or other corrosives can cause burns and other damage to the delicate eye tissues; painful eye inflammation frequently results from exposure of unprotected eyes to the flash of arc welders (arc eye).

In operations involving any of these hazards, workers should be provided with proper goggles or protective shields. Refer all cases of eye injury to medical care without delay. Flushing of the eye gently with copious quantities of clean, lukewarm water while awaiting medical attention helps to prevent complication and minimize the effects of the injury. Avoid rubbing or otherwise irritating the eye.

Air Pressure

Exposure to abnormally high atmospheric pressure occurs in certain occupations where compressed air shafts and caissons are used, such as in constructing bridge piers, building foundations, traffic tunnels, and in dividing operations. A too rapid increase in pressure may cause rupture of the ear drums and bleeding from the ears. On the other hand, if pressure is decreased too quickly, compressed air sickness, commonly referred to as caisson disease or "bends", may result. The condition usually occurs in the first few hours after rapid decompression, but may be delayed up to forty-eight hours. Most common symptom is severe pain in muscles and joints of the arms and legs. Itching, rash, dizziness, nausea and shock may also be present. Death may ensue rapidly or may result from secondary complications.

All such workers should be thoroughly impressed with the dangers of too rapid compression and decompression, and rules and regulations rigidly adhered to. These men are normally required to carry cards identifying them as compressed air workers and showing the location of the nearest medical lock.

Vibration Injury

Vibration from handling pneumatic hammers, caulkers, rock drills and other vibrating equipment can cause damage to hands, arms and joints. These tools are of two types — piston-operated and rotating. The most common clinical effect from prolonged use of piston-operated tools is "white fingers", a disturbance of circulation in the fingers; they become white or "dead" and go numb when exposed to cold. When warmed, they become bluish, accompanied by a burning sensation. Joint injury may develop, particularly in the right elbow, with limitation of movement and pain. "White fingers" may result after two years of exposure, but usually takes longer.

With high-speed rotating tools, some operators suffer from throbbing pains in the fingers and sharp

pains in the forearms, with accompanying stiffness and weakness in the hands. This condition can develop from within one to 72 weeks of exposure.

In both cases, about the only answer is to take these men off this type of work. In cases observed, there was little improvement of the condition as much as a year after changing jobs.

Recently, medical research indicates that the discharge of cold air from air hammers striking the hands is largely responsible for "white fingers". The condition can be prevented by warming the air or directing the discharge away from the hands.

Silicosis

Although dust hazards have been previously mentioned, one particular dust, silica, presents a problem of its own — a lung affliction called silicosis. Silica occurs in the free state in sand, sandstone, granite, and several ores, especially iron and coal. Crushing, quarrying, sandblasting, granite cutting, are the chief sources of exposure. Prolonged exposure to breathing silica dust may cause tissue changes in the lungs and the formation of small fibrous nodules in the lung tissues. Clinical symptoms are shortness of breath, decreased chest expansion, lessened work capacity, and lowered resistance to tuberculosis. Concentrations of silica dust inhaled, duration of exposure and individual differences in susceptibility all affect the possibility of contracting silicosis.

This disease develops within ten to thirty years, and may continue to progress even after exposure has ceased.

Respiratory protection and adequate ventilation are about the only means of ensuring prevention of over-exposure. Pre-employment and periodic medical check-ups, including chest X-ray, should be routine for workers who are exposed to silica dust. If the development of tuberculosis can be prevented, disability resulting from silicosis alone is usually not too serious.

Explosives

Handling of explosives such as dynamite and TNT, presents a dual hazard — dermatitis and systemic effects. The skin of some workers is sensitive to TNT, and these persons may develop skin lesions from contact. Of greater importance is the fact that TNT can cause systemic effects from absorption through the skin or inhalation of the vapour. Chief symptoms associated with dynamite, which contains nitroglycerin and nitroglycol, are throbbing headache, nausea and vomiting, and these symptoms are intensified by the drinking of alcohol. Effects disappear within hours of leaving exposure, but may return on resumption of work.

Following explosions of TNT and the nitrate explosives, nitrogen oxides are produced, the effects of which have been discussed before. Dynamite workers should therefore avoid entering the blast area until it is well ventilated.

Workers who have become sensitized to skin contact with TNT should avoid future contact.

Other Health Problems

Despite the great increase in published information on hazards of lifting heavy objects and materials, this practice still accounts for an unnecessarily high incidence of hernia. This can occur as a result of improper procedure in lifting, slips or stumbles on icy and uneven ground, or attempting to lift or carry too heavy loads.

Don't try to show how strong you are at the expense of hernia. Get help to move or carry any heavy articles.

Chronic fatigue, from lack of sleep, overwork or other cause, aside from increasing the hazard of accidents, can lower body resistance to invasion by disease or toxic agents in the environment.

Excess body weight can be a health hazard especially on jobs requiring sustained physical effort. The added weight which must be carried places greater stress on leg, back and foot muscles, causing considerable bodily discomfort and possibly postural defects. The overweight person suffers shortness of breath on exertion, increased clumsiness, intolerance to heat and excessive sweating. It is also an established fact that overweight people have a shorter life expectancy, and are more susceptible to heart and circulatory disorders, diabetes and other maladies.

Selection of Workers

Many health problems can be avoided through careful selection of workers. For example, a man with a past history of dermatitis would be a poor risk in a job where there was the possibility of contact with dermatitis-producing materials. Similarly, a past history of chronic respiratory disease should generally exclude an employee from work in dusty atmosphere.

Washing Facilities

Many skin and other health problems will disappear if adequate washing facilities are provided near the job-site and workers are educated in the importance

of cleanliness in disease prevention. To avoid the possibility of workers using harsh solvents to clean hands, an efficient "safe" hand cleaner should be provided. Where there is the chance of other body areas being contaminated, showers might well be provided with facilities for changing into clean clothes following the shift.

Drinking Water

Safe drinking water is a "must" in any occupation, and more so in outdoor construction, where there is the possibility of contamination from dusts or other materials in the environment. The practice of using an open water bucket and dipper is, to say the least, unsanitary, and drinking ice water in the heat of the summer can cause stomach upsets.

To avoid the possibility of sunstroke or other forms of heat sickness, body salt lost through perspiration should be supplemented by salt tablets administered according to a physician's recommendation.

Toilet Facilities

In outdoor construction, provision of proper toilet facilities is important from the sanitation viewpoint, as well as to prevent nuisance and odour. Advance planning is necessary to ensure accommodation for the period of peak employment.

First Aid

Although every construction crew may not have a full-time first aid man, at least one or more members should be duly qualified to administer first aid.

Workers should be impressed with the importance of getting immediate first aid for injuries or health problems to avoid later complication such as serious infection. And early first aid and medical treatment will simplify administration of Workmen's Compensation claims.

Preventive Measures

In most provinces there are provincial regulations and/or recommendations respecting medical requirements on construction jobs:

1. Employment in hazardous occupations — e.g. caisson workers, divers, lead workers, etc.
2. Continuing medical supervision of such hazards.
3. Medical care — contract medical practice in unorganized territory.
4. Sanitary facilities, first aid, etc.
5. Reporting of occupational diseases to Department of Labour or Workmen's Compensation Board.

In addition, certain engineering control measures can be very effective in preventing health problems, including substitution of less dangerous substances or procedures — e.g. trichloroethylene for carbon tetrachloride, shot blasting or liquid-suspended abrasives for sandblasting; ensuring good general ventilation and, where warranted, local exhaust ventilation to prevent too high aerial concentrations of toxic or non-toxic fumes, dusts, etc.; adequate labelling of dangerous substances; the use of protective clothing and equipment; the use of wet processes to control production of dusts; dust sampling and the use of the standard table of maximum allowable concentrations and permissible limits to guide hygienic measures.

If ionizing radiation in the form of X-rays, gamma sources and radio-active isotopes are used or encountered, contact your Department of Health for supervision of hazards involved.

Preventive health maintenance programs have proved their effectiveness where employees are gathered together in sufficiently large groups (over 200).

An ounce of prevention is worth a pound of cure — trite but true. Adherence to simple preventive measures, augmented by engineering control and adequate engineering and medical supervision will go a long way to eliminate or substantially reduce the incidence of health problems. This can be very profitable, and the savings effected far outweigh the effort or expenditure.

IMPACT OF HEART DISEASE IN ONE COMPANY

By D. C. Bews, M.D.
Medical Director
Bell Telephone Company of Canada

Everyone I expect has a fairly clear picture of the importance that cardiovascular diseases have assumed as causes of sickness and death in our population. Perhaps there is less appreciation concerning the social importance of cardiovascular disease in industrial groups and my assignment today is to discuss briefly the impact of cardiovascular diseases in the Bell Telephone Company of Canada. We know that there are varying patterns of cardiovascular disease in different countries and, even within the same country, that there are marked differences in the occurrence of such diseases depending upon age and sex distribution, occupation and many other factors. It is important therefore in evaluating the measurements that I propose to talk about to have a clear picture of the industrial population under consideration. Our Company operates in two Provinces of Canada — Ontario and Quebec and during the period of this study, had an average employee body of around 40,000 people. Close to 60% of our employees are women and most of the employees are relatively young — in fact 80% of our total employees are under 40 years of age. This particular combination of age and sex distribution obviously limits the interpretation of our findings to our own employee body in the Bell Telephone Company and I trust that this will be kept in mind. I mention this because of the tendency sometimes to use statistics or measurements which are related to one specific industry and to speak of them as applying to industry in general. The difficulty in interpreting statistics was brought out in a very recent medical article dealing with a plan of treatment for nodules in the thyroid gland. The author of the plan believes (and can prove by statistics) that some thyroid nodules should be removed and that others should not. This is in sharp contrast with the opinions of some who believe (and can prove by statistics) that nodules in the thyroid gland are of no consequence. This view contrasts also with the opinion of others who believe (and can prove by statistics) that all thyroid nodules should be removed by operation. It is obvious that considerable judgement has to be used in interpreting any statistics that deal with medical subjects.

I would like to deal with this discussion under four separate headings:

1. What is our policy concerning the placement of applicants with cardiovascular disease in the Bell Telephone Company? Do we employ such persons and what has been our experience?
2. How much sickness absence in the Company is attributable to cardiovascular disease? How much does this cost the Company in a year? What is its effect on productivity as measured in total days lost in the course of the year? What happens in our Company, when employees develop cardiovascular disease during their years of employment? — do we rehabilitate them or let them go?
3. How much cardiovascular disease is noted during Periodic Health Examinations with employees in the Company?
4. What is the Company's experience with deaths from cardiovascular disease?

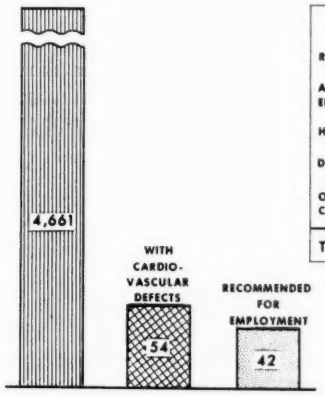
It is possible that the sum total of these experiences may give us some appreciation of the importance of these diseases in the overall health pattern of Bell Telephone employees.

What is our Company's policy in regard to employment of people with cardiovascular defects?

Last year out of 4,661 applicants (chart 1) examined by the Medical Department for jobs in the Company, 54 were found to have cardiovascular findings of sufficient severity to require special medical recommendations regarding their work capacity, limitations and placement opportunities. Of the 54, 5 men and 7 women were found to have cardiovascular defects of such severity that it was not possible for us to recommend them for employ-

Reprinted from an address given at the Joint Conference of the Ontario and Quebec Industrial Medical Groups, October, 1959.

THE BELL TELEPHONE COMPANY OF CANADA
PRE-PLACEMENT EXAMINATIONS - CARDIOVASCULAR DISEASES
MALE & FEMALE YEAR 1958



	MALE	FEMALE
RHEUMATIC HEART DISEASE	1	9
ARTERIOSCLEROTIC & DEGENERATIVE HEART DISEASE	–	3
HYPERTENSIVE DISEASE	5	14
DISEASES OF THE VEINS	–	7
OTHER DISEASES OF CIRCULATION	3	12
TOTALS	9	45

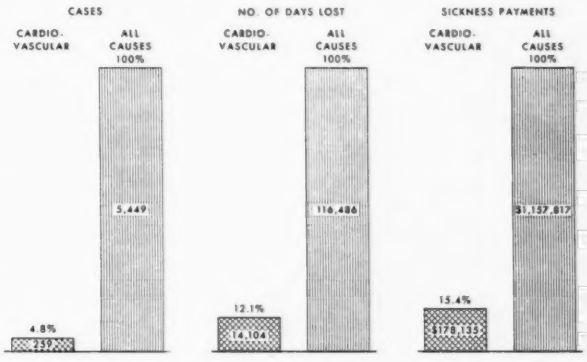
ment in the jobs for which they were applying. I should point out that this, of course, does not mean that these people couldn't do other jobs, but at the time of the examination they were applying for specific jobs and, as such, did not meet our specifications for those particular jobs. The other 42 with cardiovascular findings were placed on our payroll with the Bell last year. This may seem a relatively small number of individuals but when one considers that this goes on year after year, I think you would agree that our Company is employing its fair share of handicapped people. Last year, for example, a total of 175 employees known to have non-correctible defects at the time of employment — cardiacs, epileptics, diabetics, the after effects of poliomyelitis, arrested tuberculosis, for example, became Bell employees. With proper selection and placement, there is nothing in our experience to indicate that the employee with the cardiovascular defect is less productive than otherwise healthy persons or, that we need to be unduly worried about excessive sickness absence or sickness costs. On occasion, of course, the placement of a cardiac applicant will mis-fire but this also happens in the placement of presumably normal people from time to time. For example, one of our cardiacs who joined our staff in April, 1958, is at present in the Montreal General Hospital and has to undergo cardiac surgery in order to restore her heart function to a place where she can be rehabilitated. At the time of her employment she had been under good medical care and our own review in the Medical Department gave no indication that she would likely have a long siege of illness within a relatively short period of time.

I should point out that our ability to employ handicapped people in the Bell is aided by the fact that we have a large number of jobs which may be classified as sedentary. It is also fair to say that we have had more success in placing female applicants with cardiovascular defects than we have had in the male workers where the heavier physical demands involved in such work as linemen or telephone installers has to be considered.

How much sickness absence occurs in our Company as the result of cardiovascular disease?

In this measurement I am going to limit my remarks to the assessment of sickness absence cases lasting 8 days or more. The reason for this is that in all such cases, medical certification of absence is required in order for the employee to qualify for sickness benefits. In the Bell Telephone Company these confidential medical certificates are sent in directly to the medical department by the attending physician. In sickness absences of less than a week it would be difficult, if not impossible, to measure the extent to which cardiovascular disease contributes to the total picture although my impression is that it would not be very great. This second chart (Chart 2) shows the relationship of cardiovascular diseases to all causes of absence in terms of the number of cases, the number of days lost and the direct sickness costs to the Company. As you can see, the cardiovascular group of diseases caused 4.8% of the total cases (259 out of 5,449 cases). In terms of the number of days lost this group of diseases resulted in 12.1% of the total sickness disability days lost (14,104 out of 116,486) and in terms of cost to the Company in these diseases accounted for 15.4% of the total ($178,135 compared with $1,157,817).

THE BELL TELEPHONE COMPANY OF CANADA
SICKNESS DISABILITY - CARDIOVASCULAR DISEASES
MALE & FEMALE YEAR 1958



This chart, of course, only represents a part of the impact of sickness absence due to cardiovascular disease. It does not take into account the fact that employees who are off sick often have to be replaced by additional staff or by the present staff working overtime or that during absence, productivity of a

particular unit may go down and so on. The sickness payments on this chart are those authorized by the Company during illness and in no way reflect the total costs of medical care or hospitalization which must be borne by the employee.

THE BELL TELEPHONE COMPANY OF CANADA

SICKNESS DISABILITY - CARDIOVASCULAR DISEASES

MALE & FEMALE — YEAR 1958

	NUMBER OF CASES	TOTAL DAYS LOST	AVERAGE DAYS LOST PER CASE
VASCULAR LESIONS AFFECTING C.N.S.	8	928	116.0
RHEUMATIC FEVER AND RHEUMATIC HEART DISEASE	15	1,084	72.2
ARTERIOSCLEROTIC HEART DISEASE	57	4,546	79.8
HYPERTENSION	42	2,586	61.6
DISEASES OF VEINS	89	2,907	32.7
HYPOTENSION	26	429	16.5
ALL OTHER DISEASES OF CIRCULATORY SYSTEM	22	1,624	73.8
TOTALS	259	14,104	54.4

The above chart (Chart 3) shows a breakdown of these 259 sickness cases related to the cardiovascular system. These cases were nearly equally divided between men and women — 125 cases in men and 134 in women. However, under specific diagnostic groups, a very different picture as far as sex distribution is concerned can be readily identified. For example, in arteriosclerotic heart disease 51 of the 57 cases occurred in men which is in keeping with the sex differential and susceptibility to this disorder that has been noted on many occasions. Of the 51 cases occurring in men, 10 of them occurred in the age groups under 50, 27 occurred in the age group 50 to 59 and the remaining 14 occurred in the age groups 60 and over. A different picture was presented in the case of hypertension where 32 of the 42 sickness absences occurred in women. This is of interest because from our experience with hypertension in the two sexes, we would not expect to have such a wide variation in the sickness absence picture.

I think that it is fair to say that our Medical Department would question whether the group listed under hypotension or low blood pressure should be included in this chart on cardiovascular diseases. It is possible, I think, that the designation of a disorder related to the cardiovascular system may, in the long run, have a serious or grave emotional consequence, particularly if the attending physician implies that this finding of low blood pressure means that there is something wrong with the heart. As a matter of interest, we seldom accept this diagnosis in the Medical Department as evidence of disability because our further reviews indicate that this finding is often accompanied by other symptoms of fatigue, palpitations of the heart, light-headedness nervousness, asthenia or general debility. The employee is often advised by the personal physician to take a period of rest from work although no further therapy or treatment is apparently required. In our experience most of these cases turn out to be emotional problems of one sort or another and are not benefitted particularly by rest from the job or by running away from their problems.

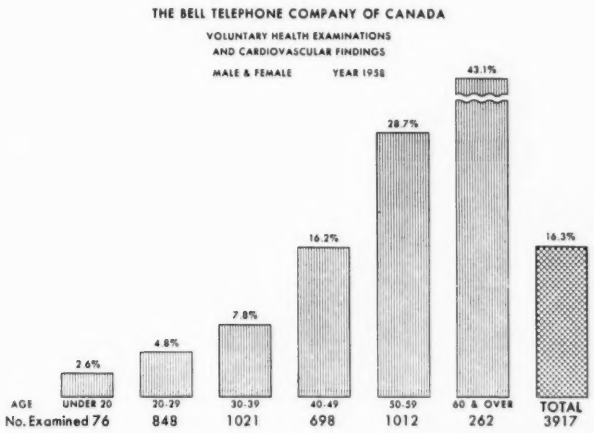
This chart (3) shows that the average days lost per case from cardiovascular diseases was 54.4 days. The average duration for absences for all causes in the same year was 30 days. As might be expected, there are fairly wide variations in the number of days lost under the different classifications of cardiovascular disease, ranging from 116 days at the top of the chart to 16½ days. A few of these cardiovascular cases were disabled for a full year and then went on pension.

What happens to the remainder of these employees when they are ready to return to work? Except in rather unusual circumstances such as already mentioned most of these employees return to duty at some stage during their convalescence. It has been our Company policy to provide suitable part time work or temporary or special assignments wherever possible, to assist in the process of the rehabilitation of cardiovascular diseases as well as all other types of illness or injury. It has been our experience that the concept of active rehabilitation, built around not only the medical but also the emotional, social and vocational needs of the employee needs to be considered in each individual case. We feel that close cooperation between the attending physician and the industrial physician who is perhaps in a more favourable position to assess the stresses and strains of a particular job, the physical demands of the job and so on, can lead to substantial benefits to the person being rehabilitated.

Practically all of the more serious cases of cardiovascular illness are offered and do avail themselves of a return to duty examination by Company doctors to see that their rehabilitation needs are being given full consideration. It has been our experience that there are few people who are well motivated to return to work for whom assignments

cannot be considered. Again, I must acknowledge that we have the greatest difficulty in the case of men who have been used to working in the more arduous types of assignments and who themselves are not too well equipped educationally or by training — to find rehabilitation assignments acceptable both to the man and the Company. I am satisfied that the Company does its best to explore all possibilities in regard to rehabilitation before any other final decision is made.

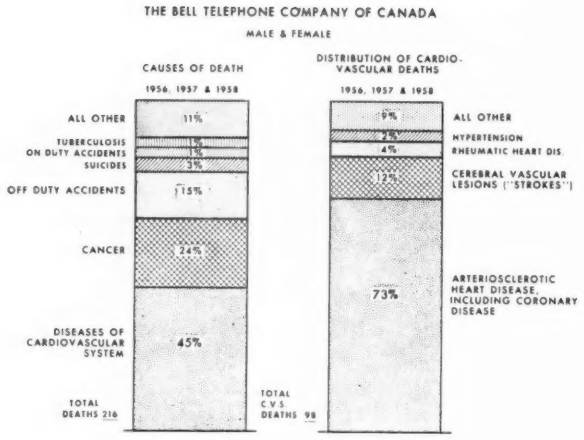
How much cardiovascular disease is found or disclosed during the course of Periodic Health Examinations in the Company?



Periodic Health Examinations are offered to employees on a purely voluntary basis. The recommended interval is yearly for the age groups 40 and over — every two or three years in the age group 30 to 39 and every three or four years in the younger age group. In 1958 nearly 4,000 employees (3,917) participated in this health maintenance activity. This Chart (Chart 4) is designed to show the percentage of employees in the various age groups who were found to have cardiovascular findings. As you can see 16.3% of the 3,917 were in this category. I would like to say that we do not record a diagnosis on these examinations unless we feel that the finding is of significance to the health picture of that particular employee. Under such a system, undoubtedly, many minor problems related to the cardiovascular system are not identified in this chart. One has to realize, of course, that this group is not a representative one as far as our employee body is concerned. These are individuals who feel that regular health examinations are worthwhile. Some of these employees have been participating in our program for several years and some of them know that they have defects related to their cardiovascular system either from previous examinations or findings of outside doctors or insurance examinations, etc. More men than women participate in this type of examination — 2,637 men as against 1,280 women. However, it is of interest to note that the percentage with cardiovascular findings increases rapidly with age which is as one might expect. Unfortunately, I cannot tell you how many new findings related to the cardiovascular system are represented in this chart. However, it does show that a significant part of our population has health problems related to their cardiovascular system. Not everyone, I know, in the medical profession agrees with the value of Periodic Health Examinations. It is our definite view in the Bell that when opportunities are provided for employees to discuss all aspects of their health with the medical staff, employees have a better understanding of their health picture. During these discussions the various health factors considered may include: symptoms, complaints, general health habits, physical examinations, review of findings, recognition of the factors within the patient and his environment which might aggravate or cause the illness or those which may promote or maintain health. Employees then know what they have to do about their health in terms of diet, weight control, exercise, recreation and general rules of health. When indicated, we urge our employees to seek additional help through their outside personal physician or specialist. The fact that many of them appear to follow our advice, seek help where indicated, and finally benefit by improved health and job performance, suggests to me that this is indeed a rewarding type of effort. This type of program is consistent with the primary objectives of health services in industries which need to be directed towards the maintenance, conservation and improvement of employee health. The Periodic Health Examination is one example of a movement that is taking place in medicine to provide for a continuing care of health in contrast to the episodic care of illness which, as you know, is still the most common underlying reason for contacts between doctors and patients in our communities today.

What has been our Company's experience as far as deaths from cardiovascular disease are concerned?

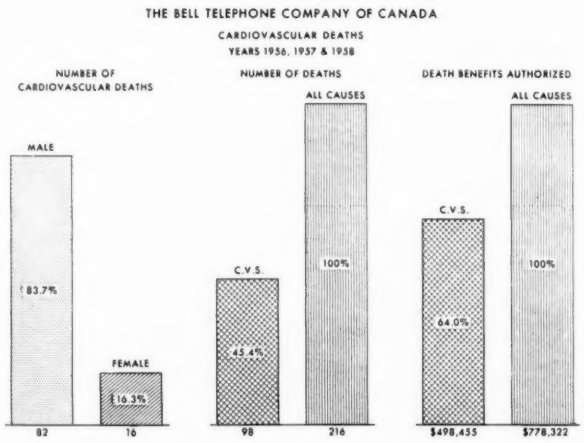
This next chart (Chart 5) shows a summary of our causes of death and the distribution of cardiovascular deaths for the past three years — 1956 — 57 — 58. On the one side of this chart you will notice that we had 216 deaths in this period of time in the Company and that diseases of the cardiovascular system account for 45% of the total. Next in line is cancer causing 24% of all deaths followed by off duty accidents which account for 15%. In the case of our Company this means that we had 32 deaths from off duty accidents compared with 2 deaths from



on duty accidents in the past three years. It is apparent that it is much safer to be on the job than off the job.

Now if we look at the other side of the chart you will see that we had 98 deaths resulting from cardiovascular diseases in the three year period. It is quite apparent that arteriosclerotic heart disease including coronary disease representing 73% of all cardiovascular deaths caused by far the large percentage of the total deaths under this heading. Another 12% resulted from cerebrovascular lesions or strokes while rheumatic fever and rheumatic heart disease caused another 4%, hypertension 2% and all other forms of cardiovascular disease 9%. These causes of death, I believe, are quite accurate as in each case we receive a copy of the death certificate signed by the attending physician or coroner to assist us in the administration of our employees death benefit plan. These certificates all come through my office so that I have the opportunity of reviewing them and coding them.

The next chart (Chart 6) shows a breakdown of the cardiovascular deaths by sex with 83.7% occurring in the males in our Company and the remaining 16.3% in the females. Many factors have to be taken into consideration in interpreting this particular chart, and I want to point out that our statistical division feels that the numbers involved in this study are quite insufficient to draw any valid statistical conclusions. Perhaps more appreciation of the full impact of these deaths in our Company may be gained by the simple statement that 75% of these cardiovascular deaths occurred in the age group under 60 years of age or that 1/3rd of our total deaths from these causes was in the age group under 50. These are losses which cannot be estimated in terms of costs or money. The next part of the chart merely emphasizes again the important part that cardiovascular deaths play in the total picture and the final part of the chart shows that cardiovascular deaths accounted for 64% of the death benefits authorized during the 3 year period. In our Company, as in many others, when an employee dies, death benefits are provided for designated dependents to help them over the difficult period of financial adjustment that results. As you can see from this chart, nearly half a million dollars was authorized as payments but, as mentioned earlier, of much greater and more significant consequence to the Company is the loss of well trained employees at an earlier stage in their lives than we like to think should be necessary.



In focusing our attention this morning on cardiovascular illness and deaths in our Company, it is possible that I may have created some impressions that our experience may be somewhat different or even worse than that which exists in the general population. I would like to point out that this is not so, for on an age-specific basis our mortality rates are lower than that of the general population in Ontario and Quebec. Also I would like to state that the rates in management people in our Company are at a more favourable level than non-management employees as far as deaths are concerned and their sickness records year after year are also consistently better. This certainly suggests to us that the acceptance of responsibility within an organization does not carry with it any likelihood of earlier death than should be expected or any increased tendency towards illness.

In summary, I have presented this subject from various points of view — the placement of the cardiac in industry, the role that this group of diseases contributes to the overall sickness picture in the Company, the opportunities of reviewing cardiovascular conditions disclosed during Periodic Health Examinations and finally the toll that these diseases have taken amongst our employees during the past three years.

THE CONTROL OF A LEAD HAZARD IN INDUSTRY

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Introduction:

Lead remains one of the commonest industrial health hazards. It is taken into the human organism either through the respiratory or the gastrointestinal tract, more commonly the former. The control of lead as a hazard fundamentally means control of the environment; failing this, the workman has to be controlled within the environment. The metal occurs industrially as organic tetraethyl lead, or as an inorganic compound. Though the former is an extremely toxic compound, it is largely confined to the petroleum industry; the latter is not quite so toxic and is found in many fields of human endeavour. Most of the ensuing remarks will concern inorganic lead and its compounds.

History:

Lead has been in industrial use since biblical times and since biblical times its uses have expanded. The first record of lead poisoning is given by Hippocrates who described abdominal cramps in a man working at extracting metals.

During the long period of the middle ages, lead was used in quite large quantities to cure wine. After some 300 years, this use fell into disrepute because some one was observant enough to recognize the deleterious effect, not to the wine but to the imbiber.

In spite of the loss of this use, lead consumption has continued to rise until to-day on the North American continent about one million tons are consumed annually. It is used widely in industry. In decreasing order of use these are:

(1) Storage battery industry.
(2) Electrical industry — cable covering.
(3) Petroleum industry — tetraethyl lead.
(4) Plumbing industry as solder.
(5) Paint industry — red lead pigment.

From this list it can be seen that it is difficult to be associated with industry as either a health nurse or industrial physician without being aware of the existence of lead or without a real or potential hazard being present.

Toxicity of Lead:

It at once becomes apparent that lead as Pb, acting mutely to shield technicians from the myriad of rays let loose in the laboratory as well as elsewhere, is no problem. Just as soon as the molecules of the metal are excited by a physical or chemical agent, a real or potential health problem rears its head which creates work for both the hygienist and the industrial physician. In order of decreasing toxicity the compounds of lead are:

(1) Tetraethyl lead
(2) Lead carbonate
(3) Lead monoxide
(4) Lead chromate
(5) Lead dioxide
(6) Lead silicate
(7) Lead sulphide

Tetraethyl lead is the only one of these compounds that can be absorbed in sufficient quantities through the skin to cause symptoms. Lead carbonate and lead monoxide are by far the most toxic of the

*Reprinted from a paper presented at the Second Occupational Health Conference held in Vancouver, March 1959.

remaining compounds. They are toxic in smaller quantities when absorbed from the respiratory tract than from the gastrointestinal tract. There must be more than two milligrams of the compounds per ten cubic metres of area, finely enough divided, 2 Mu or less, to get into the respiratory tract, to constitute a hazard. Ten cubic metres of air is used because this approximates a man's breathing requirements in an eight hour work period.

Sampling and Standards of Lead:

The only way to measure atmospheric contamination is by a sampling device. A practical one is a Whatman thimble with a sample cup through which a measured amount of air is pulled each day. The thimble is set as close to the breathing level of the men as possible and the cups collected at intervals. An ammonium acetate solution is made of the soluble compounds and the amount of these is calculated in milligrams per ten cubic metres of air. The upper limit of safe levels for the acetate soluble portion of lead has been set by the American Conference of Government Industrial Hygienists in 1958 at two milligrams per ten cubic metres. The American standards subcommittee on lead has recommended five milligrams of lead per ten cubic metres for lead chromate and sulphide. The British have used five milligrams per ten cubic metres as their standard for all compounds.

The setting of standards sounds simple enough till the question is asked, for how many eight hour days may a man breathe an atmosphere that exceeds the standards by a little or by much. The answer is that it depends on the man and many factors about the man which are difficult to measure. Clean, careful workmen who conscientiously use protective respirators and refrain from smoking on the job are less likely to be affected than the man who disregards personal and plant hygiene. It is, therefore, difficult to be precise about times that a man can work in a lead hazard. There are two facts that stand out: the first is that whenever the concentration of acetate soluble lead gets over two milligrams per ten cubic metres of air for eight hours there is a hazard; and the second is that, experimentally and practically, men lose lead in about the same number of days it takes to pick it up. This means, over a two day weekend, a man will lose two fifths of the lead he has acquired in his five working days. It further means recovery from acute lead poisoning is more rapid than from chronic lead poisoning, the former being due to a massive concentration over a short period of time.

Because there are no means of predicting how quickly a man will absorb lead, it is necessary to measure the amount of lead absorbed by all men in a real or potential hazard at intervals. These measurements will correlate with atmospheric measurements of lead.

Measurements of lead in the atmosphere should not only be used as a warning of hazard to the workmen, they should also be an indication of the adequacy of ventilation. There is no substitute for good ventilation in any plant where a toxic material is being handled. As production may outstrip ventilatory control of the atmosphere, other means have to be available to protect the men. One of these is a respirator with a filter paper designed to trap lead. These are commercially available. As good ventilation takes time to develop and instal and may at times break down, test for lead absorption in the men should be done as a routine.

Tests for Lead Absorption:

The human is a good sampling device. Reliable tests done on the workman, who is all important to our problem, give a good picture of atmospheric contamination. The tests available for lead absorption in the human are: counting stippled red cells in a blood smear, testing urines for porphyrins, measuring the amount of lead in the urine and in blood. The stipple count is still in use, by us as well as elsewhere, because it is simple. Samples are easy to get and a trained technician can learn to recognize punctate basophilia in a blood smear in a week. Because most of the lead in the blood is carried in the red cell, it was at one time assumed that the basophilic stippling was due to a degeneration in the cell, the effect of the lead. This theory has been challenged by those who present evidence to show that the stippling is produced in the bone marrow, the result of stimulation by the anæmia produced by lead. Whichever theory is correct, estimation of numbers of erythrocytes stippled is not pathognomonic for lead absorption or poisoning. Large numbers can be present with no absorption of lead and frank lead poisoning can exist without stippled cells. Where large numbers of men are being exposed to lead, the stipple test is at best a rough screen. The test for porphyrins in the urine is not precise either. It is a simple test: urine in a test tube is overlain with hydrogen peroxide, glacial acetic acid and ether and the resulting colour, if porphyrins are present, can be seen in a dark room with a mercury arc lamp. The test is reported as 1, 2, 3, or 4 depending on the deepness of the rose red colour produced. This test is probably based on the theory that lead disrupts erythrocytes releasing the porphyrins of hæmoglobin. If you remember, heme is made up of 16 pyrole rings grouped in fours, each group of four containing a molecule of iron which oxidizes to transport oxygen

from the lung. Heme is released from hæmoglobin when the red blood cell is disrupted regardless of cause. This means that there is no justification for assuming or hoping that this easy test can be of great accuracy to judge absorption of lead.

Having dismissed the two tests which can be done with ease, perhaps rather curtly, we come to the two which require special apparatus and training. These two tests are estimations of the amount of lead in the blood and the urine. They can be done as a chemical analysis or they can be done polarographically after chemical treatment to free and precipitate the lead. A recounting of the details of these tests would be boring. Suffice it to say: it takes a good technician about two months to learn how to do these tests with accuracy when working under supervision. In running known standards, the tests are accurate to plus or minus 20 micrograms per litre.

What about normal values? Generally speaking, a man can be said to be absorbing lead above normal amounts when he consistently excretes 125 micrograms per litre of urine, and he may have incapacitating symptoms when he consistently excretes over 200 micrograms per litre. Though, I have seen workmen with values above these amounts without tangible evidence of disease.

Blood lead values have not the wide fluctuations of urinary values being less influenced by fluid consumption and amount of perspiration. They may be reported as micrograms per 100 microlitres or per 100 grams of blood. This does not matter. Generally speaking, normal values are 60 micrograms or under. A rise of 70 or 80 micrograms is a definite warning, though I have seen values of over 100 without clinical evidence of disease.

Symptoms and Signs of Lead Poisoning:

What of symptoms and signs? Lead poisoning can be divided into two types. The acute and the chronic.

Acute lead poisoning once seen is unmistakable if there is an adequate history. It may come abruptly or after a period of chronicity. It is characterized by a pale, sweaty skin and abdominal cramps so violent that they force a man to bed and even the most phlegmatic writhe in agony. There is marked obstipation. The abdomen is boardlike in its rigidity.

Chronic lead poisoning is characterized by tiredness, sleepiness, pain above the joints of the arms, principally if the workman is using a sledge hammer, or about the knees if his work requires a lot of stair climbing or other leg action. There may or may not be lack of appetite and diarrhœa or constipation with vague abdominal discomfort. The only sign that I have been able to elicit with any degree of consistency is tenderness in the lower abdominal quadrants, most marked on the left.

Few are apt to see cases of acute lead poisoning and, if seen the diagnosis is easy. The diagnosis of chronic lead poisoning is based on a history of the patient working in an atmosphere containing over 2 milligrams per 10 cubic metres of soluble lead, or in metallic lead divided so finely, 2 Mu or less, that it can pass the respiratory barrier, having the symptoms as outlined and having a urinary lead value of 200 micrograms per litre or more. If there are the first two of these criteria and the urine is well under 200 micrograms, repeat the urine. If this is normal and the diagnosis remains in doubt, do a blood lead. If it is normal you are not dealing with lead poisoning.

Facilities for Small Industries:

Ventilation in the small industry should not be neglected. With realization that all facilities may not be readily available to every small plant, what can be done? It is comparatively simple to take atmospheric samples on a continuous or spot basis. A vacuum cleaner, properly modified, can extract a measured amount of air. The sample collected, preferably in a filter paper inside the bag, can be analyzed for acetate soluble lead in any city of moderate size. Failing this, rafter samples of dust can be analyzed and at least what has been in the atmosphere can be determined. The men working with lead should be on routine tests. A practical time interval is once a month and the most practical test is the estimation of stippled erythrocytes. A good nurse can be taught to take and read the slides. The results must be recorded. When the blood of any workman shows ten stipple cells per 20 microscopic fields the workman should be seen by the plant doctor. If there are symptoms, further tests should be done or, failing these, the man removed from his work place for a time. The plant physician should view these cases with the same diligent care he gives to his private patients. Very few of them should require time off work and these not more than a week or two.

In Summary:

A lead hazard exists when there are 2 milligrams of lead or more in 10 cubic metres of air in eight hours. This lead is most toxic when taken in through the respiratory tract. A suitable respirator will give some protection.

The amount of atmospheric contamination can be measured by several means.

Men working in a real or potential lead hazard should be tested at intervals for signs of lead absorption.

If there is any suspicion that a man is absorbing too much lead, he should be seen by the plant physician.

Conclusion

A well run programme designed to prevent lead poisoning should eliminate acute lead poisoning and reduce chronic lead poisoning to a minimum. The constant checking of workmen and advising management of a problem has the effect of encouraging them to improve methods to the point where the workmen are happier and the plant is more efficient. This more than justifies the cost of the programme.

NOTICE

In order to have a complete set of the Review, we require Volume 4, No. 1., October, 1952.

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